MODEL 120D

PULSE GENERATOR

SERIAL NOS. PREFIXED A

E-H RESEARCH LABORATORIES, INC.
163 ADELINE STREET · OAKLAND 20, CALIFORNIA

MODEL 120D

PULSE GENERATOR

SERIAL NOS. PREFIXED A

TABLE OF CONTENTS

SPECIFICATIONS

OPERATING INFORMATION

THEORY OF OPERATION

MAINTENANCE & CALIBRATION

PARTS LIST

SCHEMATICS

EH RESEARCH LABORATORIES, INC.

163 ADELINE STREET • TEmplebar 4-3030 • OAKLAND 20, CALIFORNIA

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_09114

SPECIFICATIONS

The new E-H Model 120D is a flexible, fast, double Pulse Generator which is quality engineered to meet high performance standards. The fast rise time and high repetition rate make it unexcelled for general laboratory use in development, production and testing of diodes, fast transistors, cables, pulse transformers, delay lines and video amplifiers . . . for development and design work in the computer field, and for rf and nuclear applications.

REPETITION RATE

100 cps to 10 MC meeting all specifications, and useful pulse output to 20 MC, internally controlled. (See Note regarding 20 MC repetition rates.) The instrument may be externally driven from zero to 20 MC.

OUTPUTS

There are two outputs. The amplitude of each is independently and continuously variable from 2 to 20 volts, negative. The outputs are a-c coupled and have a characteristic impedance of 50 ohms. (Use E-H Model ZT Pulse Transformers to invert the pulse and to match to other impedances.)

RISE TIME

Rise time is a function of amplitude. At 10 volts output the rise time is less than 0.85 nanoseconds -- typically 0.6 nanoseconds. At 20 volts amplitude the rise time is less than 1.5 nanoseconds -- typically 1.2 nanoseconds.

Fall time is approximately one nanosecond at 10 volts output, and two nanoseconds at 20 volts output.

PULSE WIDTH

10 to 100 nanoseconds, continuously variable by coarse selector and fine vernier front panel control. The widths of both output pulses are controlled simultaneously and are identical.

DUTY CYCLE

15 per cent maximum duty cycle. An overload relay with front panel indication and reset automatically protects the instrument from damage from excessive duty cycle.

TRIGGER

For sync purposes, a negative trigger pulse approximately 4 volts in amplitude and approximately 100 nanoseconds wide is provided. The trigger is 120 nanoseconds advanced with respect to the output pulse, for convenient use with sampling oscilloscopes.

EXTERNAL DRIVE

A 4 volt negative pulse is required to externally drive the Model 120D.

GATE

A negative 5 volt signal applied to the gate input will interrupt the pulse train for the duration of its presence.

DIMENSIONS

Cabinet mounted:	6" high, 17" wide, 12" deep
Rack mounted:	7" high, 19" wide, 12" deep
Weight:	27 lbs. net; 34 lbs. packed; 46 lbs. packed for export.

ACCESSORIES

Use Model RT Rise Time Integrators to obtain precise rise times in applications where responses to slower rise times are important. Standard rise times of 5, 10, 20, 50, and 100 nanoseconds; other values on special order. Price $35.

Use Model 921 Variable Delay Generator between an external driving source and a Model 120D to obtain precision pulse positioning; or between two or more Model 120D's. Continuously variable delays from 50 nanoseconds to 100 microseconds. Price $425.

For less stringent applications use Model 124 Pulse Generator: 10 volts output, 2 nanoseconds rise time, 10 MC repetition rate. Price $950.

E-H manufactures a broad line of Pulsers and accessories. Ask your local representative for a demonstration.

NOTE: The Model 120D incorporates the most advanced design techniques and components. However, certain performance anomalies may occur in the 10 to 20 MC region. These are as follows:

Some width variation with change in repetition rate.

Maximum pulse width of 7.5 nanoseconds at 20 MC (15 per cent duty cycle).

A few per cent width jitter.

Possible degradation of rise time of approximately 20 per cent.

Possible occurence of one or two discrete frequencies at which no output is available.

Except for the possible conditions listed above, all specifications apply at all repetition rates.

Warranty

This instrument is guaranteed to be free of defects in materials and workmanship for a period of one year following delivery. Excluded items under this warranty are tubes, fuses, transistors, and diodes. In the event of failure, written notice of the nature of the trouble and the instrument serial number should be sent to the factory. E-H Research Laboratories, Inc., will then send instructions for component replacement or return shipment to the factory or local representative.

OPERATING INFORMATION

OUTPUT IMPEDANCE

The Model 120D is a current source designed to operate into a 50 ohm resistive load. If the instrument is terminated in other than 50 ohms, a mismatch will occur--resulting in excessive overshoot and waveform distortions. Operation of the instrument unterminated (open-circuit) will seriously reduce the life and performance of the output tubes.

In order to deliver all the available power to the external load, the outputs of the Model 120D have not been backmatched in 50 ohms. The impedance looking into the output connectors is actually very high. In some applications backmatching may be necessary, and a 50 ohm pad can be placed across the output connector.

DC RESTORATION

The output of the Model 120D is AC coupled in order to provide the fastest possible rise time. DC restoration is possible with a small accessory. Further information about this DC restorer can be obtained from your E-H Research Laboratories sales representative.

CABLES, CONNECTORS, & ATTENUATORS

The sharp rising pulse of the Model 120D has appreciable frequency components up to 1 kilomegacycle. If any of these high frequency components are attenuated through the use of connectors, cables, or attenuators that do not have a flat frequency response to frequencies in excess of 1 kilomegacycle, the result will be a degrading of the pulse rise time. Mismatch effects can also degrade the pulse waveform. Consequently, some consideration and care must be taken to preserve the quality of the pulse output of the Model 120D when coupling it to the system or device under test.

Some of the precautions to observe in coupling the Model 120D pulse outputs are:

1. Always terminate the output of the Model 120D in a 50 ohm resistive load.

2. If the input impedance of the device or system under test is other than 50 ohms, use an impedance matching device so that mismatch effects will not degrade the pulse waveform.

3. Make sure that all connectors, attenuators, and cables are of proper impedance and have a flat frequency response in excess of 1 kilomegacycle. The GR and Tektronix coaxial attenuators are recommended for use, as well as the GR Type 875 hermaphrodite coaxial connectors. 50 ohm cable must be used at the Model 120D BNC output connectors. RG-8A/U cable is recommended. Both RG-58A/U and RG-174/U will cause appreciable loss of rise time if lengths larger than a few inches are used.

MEASURING RISETIME & WAVEFORM

The pulse characteristics of the Model 120D can best be observed on the Tektronix Type 519 oscilloscope. The very fast rise time of this oscilloscope (about 0.30 nanoseconds) and its clean pulse response make it the recommended instrument for observing the Model 120D characteristics.

Reasonable precautions must be taken in connecting the pulse generator to the oscilloscope. (See the paragraph in this Section on CABLES, CONNECTORS & ATTENUATORS.) The Type 519 oscilloscope should be internally synced, rather than externally. (See the paragraph on TRIGGER OUTPUT operation.) In addition, the sweep speed of the oscilloscope should be calibrated so that rise time can be measured accurately. The rise time specification is tested at the factory with the waveform controls adjusted to provide 5 per cent overshoot.

When measuring rise time, it is important to take into consideration the rise time of the oscilloscope.

For gaussian functions the rise time observed on the oscilloscope is, to a first approximation, equal to the square root of the sum of the squares of the oscilloscope rise time and the pulse rise time of the Model 120D.

For example:

Observed rise time	=	0.8 nanoseconds
Scope rise time	=	0.35 nanoseconds
Pulse rise time	=	$\sqrt{(0.8)^2 - (0.35)^2}$
	=	$\sqrt{0.64 - 0.12}$
	=	$\sqrt{0.52}$
	=	0.72 nanoseconds

The word "gaussian" is underlined in the previous paragraph because some sampling oscilloscopes do not have a gaussian rise. With these samplers the effect of the oscilloscope on the rise time being measured cannot be taken into account so simply. The Tektronix Type 519 does have an approximate gaussian rise.

Even when great attention is paid to cabling and impedance matching, it is likely that some waveform devia-

CONTROL	OPERATION
FREQ. RANGE	The internal repetition rate is controlled by a coarse FREQ. RANGE selector which is calibrated in decade steps (except for the 10 to 20 megacycle range). The FINE control provides continuous coverage within the selected decade range.
WIDTH	The coarse WIDTH selector switch and FINE control vary the width of the output pulses from 10 to 100 nanoseconds.
AMPLITUDE	These continuous controls independently select the amplitude of the pulses received from channel 1 and channel 2.
WAVEFORM	A screwdriver adjust waveform control for each output channel is located on the rear panel. This control determines the amount of overshoot and, to some extent, the waveform of the first 10 to 15 nanoseconds of the output pulse. It also has an effect on pulse amplitude. The control should be adjusted while observing the output pulse on an oscilloscope. Once it is adjusted as desired, it should not need readjustment unless a component in the output chain is replaced.
OVERLOAD RESET	This is a visual indication that the 15 per cent duty cycle limitation has been exceeded. The duty cycle should be corrected and the reset button pushed to restore normal operation.
PULSE OUTPUT	Each connector provides an independent pulse train designed to operate into a 50 ohm resistive load.
TRIGGER OUTPUT	The trigger output is a negative 4 volt pulse typically 100 nanoseconds wide. It is directly coupled to the front panel BNC connector through 510 ohms. The trigger output should not be connected to any active device. The signals generated by an active device can interfere with the timing circuitry of the Model 120D.
GATE INPUT	A negative 5 volt signal is required to gate the instrument. If the gating frequency is not synchronized with the pulse repetition rate, one spurious pulse can occur immediately after the gating signal is removed. There can be some DC shift in the pulse chain after it is gated under certain conditions. These conditions are low gating frequency and high duty cycle.
EXT. DRIVE INPUT	To drive the instrument externally, the FREQ. RANGE selector must be set to EXT. and a negative 4 volt trigger applied to the EXT. DRIVE INPUT connector. With the FREQ. RANGE selector set to EXT., the FINE frequency functions as a trigger sensitivity control. As the control is rotated clockwise the input becomes increasingly sensitive to an external drive trigger. At a full clockwise position the instrument will typically free run.
AC	For optimum tube life the AC switch should be turned on at least 30 seconds before the DC switch.

tions will be observed on the oscilloscope presentation that are not present at the Model 120D output connectors. Considerable judgment must be exercised in interpreting the oscilloscope presentation. Several observations should be made under different measuring conditions to help in determining what part of the oscilloscope presentation is due to mismatch effects and oscilloscope characteristics (rise time, overshoot, amplifier, linearity, etc.).

Some of the pulse characteristics you are likely to observe on a 10 volt amplitude pulse are as follows:

1. Approximately 0.6 volts preshoot.
2. Pulse top distortion of less than 1 volt peak-to-peak. This distortion occurs in the first 10 or 15 nanoseconds of the pulse, and its shape is somewhat variable by the waveform control. The remainder of the pulse top is essentially free of distortion.
3. Distortion of approximately 1 volt peak-to-peak amplitude of the base line immediately after the pulse.
4. No sag.
5. No ringing.
6. Variable overshoot (waveform controls).

Observation of characteristics appreciably different from those listed above will usually be traceable to the measurement apparatus. Reflections that have a period of 5 nanoseconds may be traceable to a mismatch at the instrument's output connector, since 5 nanoseconds is the approximate propagation time of the internal cable which connects the plate of the output tube to the output connector.

PULSE WIDTHS LESS THAN 10 NS.

The minimum specified pulse width of the Model 120D is 10 nanoseconds. However, the instrument can deliver pulses narrower than 10 nanoseconds width by appropriate adjustment of the width controls and the variable timing capacitor C58. Usefulness of the pulses at widths narrower than 10 nanoseconds is limited primarily by three effects.

1. The rise time tends to become slower as the width is decreased to 6 or 7 nanoseconds.
2. Jitter begins to appear on the trailing edge of the pulse as the width is decreased much below 10 nanoseconds.
3. There is, characteristically, a considerable amount of width variation with repetition rate at widths below 10 nanoseconds.

PULSE WIDTHS GREATER THAN 100 NS.

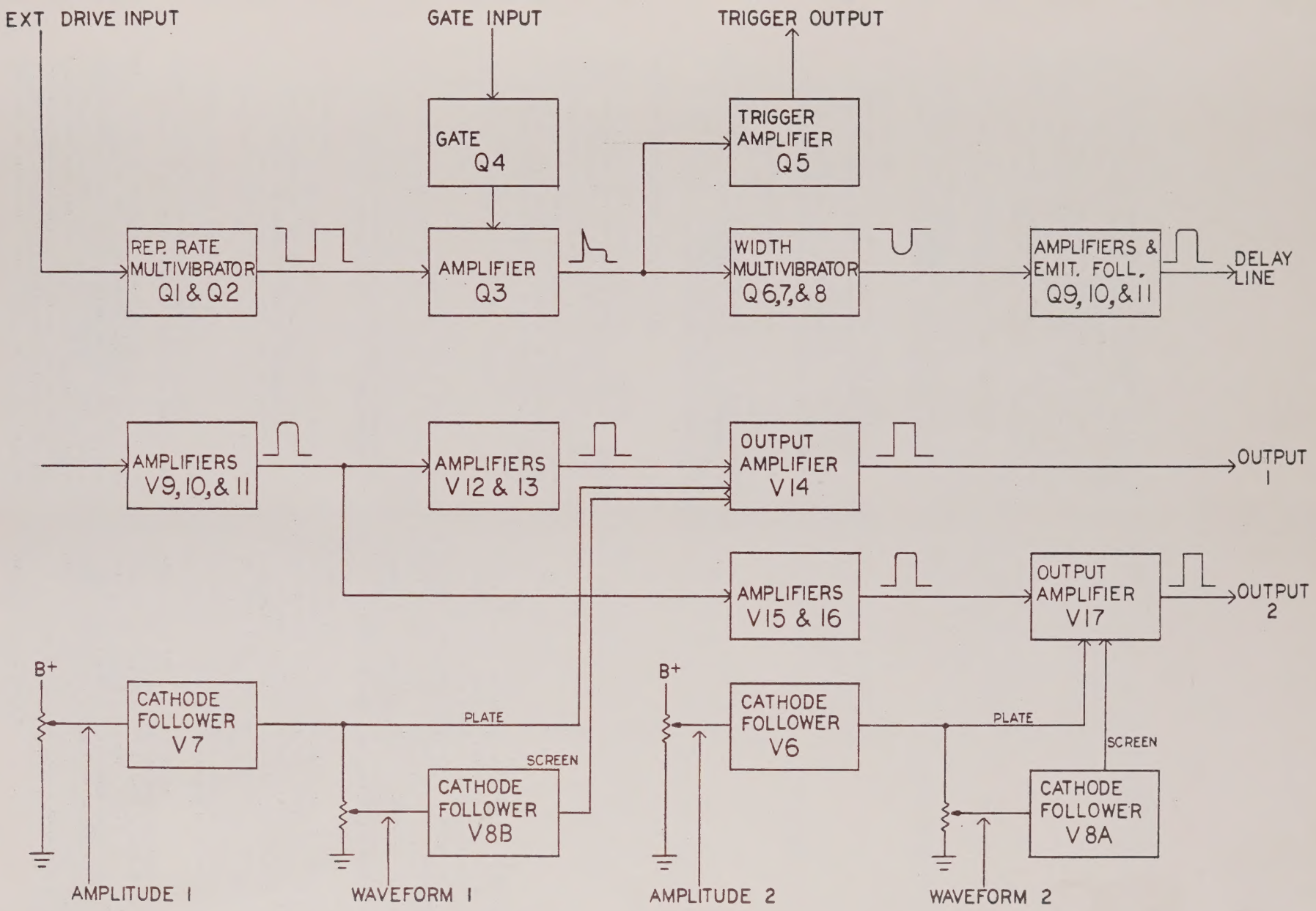
Although the specifications limit the maximum pulse width of the Model 120D to 100 nanoseconds, the instrument will deliver wider pulses. Typically, the maximum pulse width is approximately 140 nanoseconds. At low duty cycles, these wide pulses have no aberrations. However, a 140 nanosecond wide pulse will start to sag as the duty cycle is increased to approximately 10 or 11 per cent, and the sag becomes increasingly pronounced as the duty cycle increases further.

DUTY CYCLE EFFECTS

Over the specified range of pulse widths and amplitudes there is very little duty cycle effect. Typically, the pulse amplitude decreases about 10 per cent and the pulse width a few per cent as the duty cycle is increased from essentially zero to 15 per cent. There is no degrading of pulse rise or fall times as a result of duty cycle, and there is typically less than 5 per cent pulse sag at 100 nanoseconds width and 15 per cent duty cycle.

The duty cycle limitation is to insure long tube life by conservative operation of the tubes. The overload relay is typically adjusted so that duty cycles a little in excess of the rated 15 per cent are available -- the exact overload tripping point being a function of the amplitudes of the two output pulses. With both pulses at maximum amplitude the limiting occurs at very nearly 15 per cent duty cycle. With both pulse amplitudes at minimum duty cycle limiting will occur at 18 to 20 per cent.

If slightly higher duty cycles are required, they can be obtained at the expense of tube life by increasing the value of resistor R203 on the overload relay. In no event can the instrument be modified to provide greater than 20 per cent duty cycle with both pulse amplitudes set to 20 volts. Amplitude and width variations with duty cycle will be more pronounced if the instrument is modified to operate at duty cycles higher than 15 per cent. However, there should be no change in rise time or pulse waveform.



120D BLOCK DIAGRAM FIG 1

THEORY OF OPERATION

GENERAL DESCRIPTION

Refer to the block diagram on the opposite page. The internal pulse repetition rate is determined by a free-running multivibrator capable of very fast operation. With the FREQUENCY range selector set to EXT. DRIVE, the multivibrator is switched to a Schmitt trigger configuration and the pulse repetition rate is determined by the external trigger repetition rate. The output of the multivibrator is then amplified. The amplifier is biased off and the pulse chain interrupted if a gating signal is applied to the instrument. The output of the amplifier is coupled both to a monostable multivibrator, which determines the pulse width and to another amplifier, which provides a negative trigger output.

The width multivibrator is non-saturating and provides a negative pulse output, the width of which is set by the front panel width controls. This pulse then goes through two stages of transistorized amplification and is delayed approximately 100 nanoseconds by a 50 ohm delay line before being applied to the shaping chain.

Five stages of transformer-coupled, Class C amplification serve to "square" the pulse until it has a rise time of one nanosecond or less. The first three stages of amplification are common to both pulse 1 and pulse 2. However, the shaping chain divides after the third amplifier, and the final shaping stages are independent for each output channel. Each output tube provides an independent output which is brought out to a front panel BNC connector. The amplitude of the output pulse is determined by the plate and screen voltage of the output tube. This is continuously and independently variable for each of the output tubes. The waveform adjustments on the rear panel of the instrument determines the plate to screen voltage ratio of the output tubes.

There are four regulated power supplies. There is a high voltage supply for the shaping chain and the output tubes, and two low voltage supplies for the transistorized timing circuitry. These supplies are conventional feedback regulated. The fourth supply is established across a 9.1 volt zener diode. This supply is used for biasing the shaping chain and output tubes.

REP RATE MULTIVIBRATOR

Q1 and Q2 comprise a free-running multivibrator capable of running at very fast repetition rates. To understand the operation of this multivibrator, assume that the switching is as shown on the schematic and that the timing capacitor has charged up to some positive value. Q1 is consequently turned off and Q2 is forced into conduction by the negative bias obtained through R1, R7, and CR1. The timing capacitor on the base of Q1 will discharge through variable resistor R53 and R6 to the negative voltage level at the base of Q2.

It is important to note that because Q2 is conducting there is a voltage drop across R5 and, consequently, the emitter voltage of Q2 is less than the emitter voltage of Q1. Thus, the timing capacitor on the base of Q1 will discharge to the voltage level at the base of Q2 until such time as the base emitter drop of Q1 becomes less than the base emitter drop of Q2. Q1 will then start to conduct; its collector voltage will start to go positive; and this in turn will cause the base of Q2 to go positive, forcing it out of conduction.

The timing capacitor now takes on charge due to the difference in potential between the bases. As the capacitor charges, Q1 remains in conduction until the difference in potential between the bases is slightly less than the bias developed across R2. When this occurs, Q2 is forced back into conduction and Q1 becomes cut off.

AMPLIFIER & GATE

Q3 and Q4 comprise an amplifier and gate. In the quiescent condition without the presence of a gate signal, both Q3 and Q4 are non-conducting. The biases which determine the cut-off conduction of these transistors are developed across the forward resistance of several diodes. The emitters of both Q3 and Q4 are held slightly positive by the forward resistance of diode CR4. The bases are biased more positive than the emitters by the forward resistance or two diodes in series. The negative pulse output of the multivibrator is amplified by Q3 when a gating signal is not present. When a negative 5 volt gating signal is applied to the base of Q4, the common emitters of Q3 and Q4 are held several volts negative. Q3, then, cannot conduct and the pulse chain is interrupted as long as the gating signal is applied. Zener diode CR6, which zeners at 3.3 volts, protects the base of Q4 from being driven too far negative by large amplitude gating signals.

TRIGGER OUTPUT

The amplifier output is capacitively coupled to Q5, the trigger output amplifier. Q5 produces a sharp negative trigger spike, approximately 4 volts in amplitude, which is delivered to the front panel through a 510 ohm resistor.

WIDTH MULTIVIBRATOR

The output of amplifier Q3 is directly coupled to the width multivibrator, comprised of Q6, Q7, and Q8. Q8 is a low impedance source for driving the timing capacitors, while Q6 and Q7 form a monostable multivibrator.[4] In the stable condition Q7 is biased on -- the bias being developed across the forward resistance of diode CR11. With Q7 on, Q6 is forced into non-conduction.

The input to the multivibrator is the base of Q8. It is an emitter follower, and whenever a positive input pulse

is received from the previous stage, it is coupled through Q8 and one of the timing capacitors to the base of Q7. Q7, which is normally conducting, is cut off by the positive swing and Q6 is forced into conduction. As Q6 goes into conduction, its collector voltage goes positive. The collector of Q6 is tied to the base of Q8 so the action becomes regenerative, and the multivibrator very rapidly switches to its quasi-stable state until the timing capacitor has discharged through variable resistor R55 and resistor R54. Variable resistor R55 controls the discharge time and serves as the FINE WIDTH control.

The output of the width multivibrator is a small negative pulse taken from the collector of Q7. The width of this pulse is determined by the quasi-stable period of the multivibrator which is, in turn, set by the front panel width controls. This negative pulse is coupled to the base of the following amplifier Q9.

TRANSISTOR AMPLIFIERS

Q9 and Q10 amplify the positive output of the width multivibrator. Emitter follower Q11 sets the base and emitter voltages of Q9 so that the output pulse is at the exact voltage level needed for the input to the vacuum tube amplifying and shaping chain which follows. The output of the amplifier is delayed approximately 100 nanoseconds by a delay line before it reaches the grid of the first shaping tube.

AMPLIFIER & SHAPING CHAIN

Tubes V9-V13, V14, and V15 are transformer-coupled, Class C amplifiers. The pulse output from the timing circuitry is successively amplified and shaped by tubes V9 through V11. The chain then splits with the output of V11 being coupled simultaneously to V12 and V15. These tubes, along with V13 and V16, provide further amplification and shaping of the pulse until a rise time of one nanosecond or less can be achieved at the outputs.

OUTPUT STAGES

The outputs of V13 and V16, the final tubes in the shaping chains, are transformer coupled to the grids of the two output tubes, V14 and V17, respectively. The output tubes are operated Class C and are independent of one another--having separate amplitude and waveform controls. The amplitude of the output pulse is determined by simultaneously varying the plate and screen voltage of the output tube. V6 and V7 are the cathode followers which supply the plate voltage. The output of V6 is divided down by R231 and R232 and fed to one-half of the cathode follower V8, which supplies the screen voltage to V17. The ratio of the plate voltage to the screen voltage is determined by R231, the waveform control for output 2. Variable resistor R236 serves similarly as the waveform control for output 1.

The output pulses are AC coupled through parallel capacitors and short lengths of RG 141/U, 50 ohm cable, to the output connectors. Considerable care has been taken in the design and construction of the output section to eliminate ground loops, spurious oscillations, and rise time degrading effects. Component placement, lead length, and lead dress are vital to the best operation of the instrument and should be duplicated as closely as possible when component replacements are made.

POWER SUPPLY

There are four regulated supplies in the Model 120D- a +150 volt supply for the shaping chain and output section, a -9 volt supply for biasing of the amplifiers in the shaping chain, and transistor supplies of +5.2 volts and -5.2 volts.

The +150 volt supply operates conventionally and is composed of three 6080 regulators in parallel, a 6AU6 control tube, and a 5651 VR tube. The +150 volts is set by variable resistor R211.

The -9.1 volt supply is simply developed across a 9.1 volt zener diode. Each low voltage transistor supply is composed of a series regulator and a feedback amplifier. Both supplies are referenced to a 6.2 volt zener diode. The +5.2 volt level and the -5.2 volt level are both set simultaneously by dividing the reference voltage through variable resistor R244 and fixed resistor R245.

The duty cycle limiter is composed of an overload relay, a reset button, and an overload indicator light. The overload relay monitors the current through R230 and R238, the cathode resistors of V6 and V7, respectively. When this current becomes escessive -- indicating a duty cycle greater than 15 per cent -- the relay trips and the plate and screen supplies of the amplifier chain and output tubes are disengaged. Hold current for the relay is taken from the raw supply to the transistorized voltage regulator.

PARTS LIST

RESISTORS

R1	100 ohms	5%	1/4 W	Fixed, composition
R2	10 ohms	5%	1/4 W	Fixed, composition
R3	180 ohms	5%	1/4 W	Fixed, composition
R4	150 ohms	5%	1/4 W	Fixed, composition
R5	10 ohms	5%	1/4 W	Fixed, composition
R6	220 ohms	5%	1/4 W	Fixed, composition
R7	1 K	5%	1/4 W	Fixed, composition
R8	Not used.			
R9	Not used.			
R10	3.9 K	5%	1/4 W	Fixed, composition
R11	330 ohms	5%	1/4 W	Fixed, composition
R12	18 K	5%	1/4 W	Fixed, composition
R13	2.4 K	5%	1/4 W	Fixed, composition
R14	510 ohms	5%	1/4 W	Fixed, composition
R15	220 ohms	5%	1/4 W	Fixed, composition
R16	180 ohms	5%	1/4 W	Fixed, composition
R17	30 K	5%	1/4 W	Fixed, composition
R18	100 ohms	5%	1/4 W	Fixed, composition
R19	750 ohms	5%	1/4 W	Fixed, composition
R20	330 ohms	5%	1/4 W	Fixed, composition
R21	430 ohms	5%	1/4 W	Fixed, composition
R22	68 ohms	5%	1/4 W	Fixed, composition
R23	51 ohms	5%	1/4 W	Fixed, composition
R24	Not used.			
R25	Not used.			
R26	3.9 K	5%	1/4 W	Fixed, composition
R27	390 ohms	5%	1/4 W	Fixed, composition
R28	100 ohms	5%	1/4 W	Fixed, composition
R29	1.2 K	5%	1/4 W	Fixed, composition
R30	10 ohms	5%	1/4 W	Fixed, composition
R31	1.8 K	5%	1/4 W	Fixed, composition
R32	3.6 K	5%	1/4 W	Fixed, composition
R33	10 K	5%	1/4 W	Fixed, composition
R51	2 K	5%	1/2 W	Fixed, composition
R52	100 K	5%	1/2 W	Fixed, composition
R53	5 K		2 W	Var., composition
R54	1 K	5%	1/2 W	Fixed, composition
R55	5 K		2 W	Var., Helipot
R101	100 ohms	5%	1/2 W	Fixed, composition
R102	100 ohms	5%	1/2 W	Fixed, composition
R103	51 ohms	5%	1/2 W	Fixed, composition
R104	75 ohms	5%	1 W	Fixed, composition
R105	10 ohms	5%	1/2 W	Fixed, composition
R106	390 ohms	5%	1 W	Fixed, composition
R107	10 ohms	5%	1/2 W	Fixed, composition
R108	130 ohms	5%	2 W	Fixed, composition
R109	150 ohms	5%	2 W	Fixed, composition
R110	10 ohms	5%	1/2 W	Fixed, composition
R111	1 K	5%	1 W	Fixed, composition
R112	10 ohms	5%	1/2 W	Fixed, composition
R113	100 ohms	5%	2 W	Fixed, composition
R114	130 ohms	5%	2 W	Fixed, composition
R115	10 ohms	5%	1/2 W	Fixed, composition
R116	3 K	5%	1/2 W	Fixed, composition
R117	680 ohms	5%	1 W	Fixed, composition
R118	10 ohms	5%	1/2 W	Fixed, composition
R119	120 ohms	5%	2 W	Fixed, composition
R120	120 ohms	5%	2 W	Fixed, composition
R121	10 ohms	5%	1/2 W	Fixed, composition
R122	510 ohms	5%	1 W	Fixed, composition
R123	750 ohms	5%	2 W	Fixed, composition
R124	750 ohms	5%	2 W	Fixed, composition
R125	10 ohms	5%	1/2 W	Fixed, composition
R126	130 ohms	5%	2 W	Fixed, composition
R127	10 ohms	5%	1/2 W	Fixed, composition
R128	100 ohms	5%	1/2 W	Fixed, composition
R129	Not used.			
R130	100 ohms	5%	1/2 W	Fixed, composition
R131	100 ohms	5%	1/2 W	Fixed, composition
R132	10 ohms	5%	1/2 W	Fixed, composition
R133	680 ohms	5%	1 W	Fixed, composition
R134	10 ohms	5%	1/2 W	Fixed, composition
R135	120 ohms	5%	2 W	Fixed, composition
R136	120 ohms	5%	2 W	Fixed, composition
R137	10 ohms	5%	1/2 W	Fixed, composition
R138	510 ohms	5%	1 W	Fixed, composition
R139	750 ohms	5%	2 W	Fixed, composition
R140	750 ohms	5%	2 W	Fixed, composition
R141	10 ohms	5%	1/2 W	Fixed, composition
R142	130 ohms	5%	2 W	Fixed, composition
R143	10 ohms	5%	1/2 W	Fixed, composition
R144	100 ohms	5%	1/2 W	Fixed, composition
R145	Not used.			
R146	100 ohms	5%	1/2 W	Fixed, composition
R147	100 ohms	5%	1/2 W	Fixed, composition
R148	10 ohms	5%	1/2 W	Fixed, composition
R201	5 ohms	10%	10 W	Fixed, wire wound
R202	4.7 ohms	5%	1 W	Fixed, composition
R203	Selected	5%	1/2 W	Fixed, composition
R204	10 ohms	10%	10 W	Fixed, wire wound
R205	220 K	5%	1/2 W	Fixed, composition
R206	1 M	5%	1/2 W	Fixed, composition
R207	82 K	5%	1/2 W	Fixed, composition
R208	27 K	5%	1/2 W	Fixed, composition
R209	36 K	5%	1 W	Fixed, composition
R210	150 K	5%	1/2 W	Fixed, composition

R211	50 K		2 W	Var., composition
R212	180 K	5%	1/2 W	Fixed, composition
R213	100 ohms	5%	1/2 W	Fixed, composition
R214	22 ohms	5%	1/2 W	Fixed, composition
R215	22 ohms	5%	1/2 W	Fixed, composition
R216	100 ohms	5%	1/2 W	Fixed, composition
R217	100 ohms	5%	1/2 W	Fixed, composition
R218	22 ohms	5%	1/2 W	Fixed, composition
R219	22 ohms	5%	1/2 W	Fixed, composition
R220	100 ohms	5%	1/2 W	Fixed, composition
R221	100 ohms	5%	1/2 W	Fixed, composition
R222	22 ohms	5%	1/2 W	Fixed, composition
R223	22 ohms	5%	1/2 W	Fixed, composition
R224	100 ohms	5%	1/2 W	Fixed, composition
R225	10 K	10%	10 W	Fixed, wire wound
R226	10 ohms	5%	1/2 W	Fixed, composition
R227	100 K		2 W	Var., composition
R228	100 ohms	5%	1/2 W	Fixed, composition
R229	10 ohms	5%	1/2 W	Fixed, composition
R230	7.5 K	10%	5 W	Fixed, wire wound
R231	50 K		2 W	Var., composition
R232	51 K	5%	1/2 W	Fixed, composition
R233	110 K	5%	1/2 W	Fixed, composition
R234	110 K	5%	1/2 W	Fixed, composition
R235	51 K	5%	1/2 W	Fixed, composition
R236	50 K		2 W	Var., composition
R237	10 ohms	5%	1/2 W	Fixed, composition
R238	7.5 K	10%	5 W	Fixed, wire wound
R239	100 ohms	5%	1/2 W	Fixed, composition
R240	100 ohms	5%	1/2 W	Fixed, composition
R241	100 K		2 W	Var., composition
R242	82 K	5%	1/2 W	Fixed, composition
R243	12 K	5%	2 W	Fixed, composition
R244	200 ohms		1/4 W	Var., composition
R245	510 ohms	5%	1/2 W	Fixed, composition
R246	1 K	5%	1/2 W	Fixed, composition
R247	330 ohms	5%	1/2 W	Fixed, composition
R248	100 ohms	5%	1/2 W	Fixed, composition
R249	330 ohms	5%	1/2 W	Fixed, composition
R250	1 K	5%	1/2 W	Fixed, composition
R251	511 ohms	1%	1/2 W	Fixed, depos.carbon
R252	475 ohms	1%	1/2 W	Fixed, depos.carbon
R253	20 ohms	1%	1/2 W	Fixed, composition
R254	100 K	5%	1/2 W	Fixed, composition

CAPACITORS

C1	25 ufd	-20 +80%	Fixed
C2	.01 ufd	20%	Fixed
C3	25 ufd	-20 +80%	Fixed
C4	.01 ufd	20%	Fixed
C5	.001 ufd	20%	Fixed
C6	50 pf	10%	Fixed
C7	100 pf	10%	Fixed
C8	50 pf	10%	Fixed
C9	10 pf	10%	Fixed
C10	25 uf	-20 +80%	Fixed
C11	.01 uf	20%	Fixed
C12	25 uf	-20 +80%	Fixed
C13	.01 uf	20%	Fixed
C14	.01 uf	20%	Fixed
C15	.01 uf	20%	Fixed
C16	.1 uf	20%	Fixed
C17	.1 uf	20%	Fixed
C51	100 pf	10%	Fixed
C52	2.0 uf	-20 +80%	Fixed
C53	0.2 uf	-20 +80%	Fixed
C54	.02 uf	-20 +80%	Fixed
C55	.002 uf	-20 +80%	Fixed
C56	100 pf	10%	Fixed
C57	7-45 pf		Var.
C58	7-45 pf		Var.
C59	30 pf	10%	Fixed
C60	75 pf	10%	Fixed
C101	.01 uf	20%	Fixed
C102	.01 uf	20%	Fixed
C103	.01 uf	20%	Fixed
C104	.01 uf	20%	Fixed
C105	.01 uf	20%	Fixed
C106	.01 uf	20%	Fixed
C107	.01 uf	20%	Fixed
C108	.01 uf	20%	Fixed
C109	.01 uf	20%	Fixed
C110	.001 uf	20%	Fixed
C111	.01 uf	20%	Fixed
C112	.001 uf	20%	Fixed
C113	.01 uf	20%	Fixed
C114	.001 uf	20%	Fixed
C115	.01 uf	20%	Fixed
C116	0.1 uf	20%	Fixed
C117	.001 uf	20%	Fixed
C118	0.1 uf	20%	Fixed
C119	Two Sided, Printed CCT. Board, E-H Part. No. B-10378-01		
C120	.01 uf	20%	Fixed
C121	.01 uf	20%	Fixed
C122	.001 uf	20%	Fixed
C123	.01 uf	20%	Fixed
C124	.001 uf	20%	Fixed
C125	.01 uf	20%	Fixed
C126	Two Sided, Printed CCT. Board, E-H Part No. B-10378-01		
C127	.001 uf	20%	Fixed
C128	.01 uf	20%	Fixed
C129	0.1 uf	20%	Fixed
C130	.001 uf	20%	Fixed
C131	0.1 uf	20%	Fixed
C201	250 uf	-20 +80%	Fixed
C202	30 uf	-20 +80%	Fixed
C203	0.1 uf	20%	Fixed
C204	10 uf	-20 +80%	Fixed
C205	.001 uf	20%	Fixed
C206	.001 uf	20%	Fixed
C207	10 uf	-20 +80%	Fixed
C208	1000 uf	-20 +80%	Fixed
C209	1000 uf	-20 +80%	Fixed
C210	25 uf	-20 +80%	Fixed
C211	25 uf	-20 +80%	Fixed
C212	.01 uf	20%	Fixed
C213	.01 uf	20%	Fixed
C214	.01 uf	20%	Fixed
C215	10 uf	-20 +80%	Fixed
C216	.001 uf	20%	Fixed
C217	.001 uf	20%	Fixed

DIODES

CR1	1 N 751A	Continental Devices
CR2	1 N 914B	Texas Instruments
CR3	Q 6-100	International Diode
CR4	1 N 270	Sylvania
CR5	1 N 270	Sylvania
CR6	1 N 746A	Texas Instruments
CR7	1 N 270	Sylvania
CR8	1 N 270	Sylvania
CR9	1 N 914B	Texas Instruments
CR10	Q 6-100	International Diode
CR11	O 6-100	International Diode
CR12	O 6-100	International Diode
CR13	1 N 914B	Texas Instruments
CR14	1 N 914B	Texas Instruments
CR15	1 N 270	Sylvania
CR51	1 N 746A	Texas Instruments
CR201	1 N 2071	Texas Instruments
CR202	1 N 2071	Texas Instruments
CR203	1 N 2071	Texas Instruments
CR204	10M9.1ZR10	Motorola
CR205	1 N 2071	Texas Instruments
CR206	1 N 2071	Texas Instruments
CR207	1 N 753	Continental Devices

INDUCTORS

L1		E-H Part No. A-10414
L2		E-H Part No. A-10414
L3	.68 uH	Miller
L4		E-H Part No. A-10414
L5		E-H Part No. A-10414
L6	.68 uH	Miller
L101	.15 uH	Miller
L102	.33 uH	Miller
L103	.33 uH	Miller
L104	.22 uH	Miller
L105	.33 uH	Miller
L106	.22 uH	Miller
L107	.22 uH	Miller
L108	.33 uH	Miller
L109	.68 uH	Miller
L110	.68 uH	Miller
L111	.15 uH	Miller
L112	.68 uH	Miller
L113	400 uH	E-H Part No. A-10385-01
L114	51 uH	E-H Part No. A-10386-01
L115	.22 uH	Miller
L116	.33 uH	Miller
L117	.68 uH	Miller
L118	.68 uH	Miller
L119	.15 uH	Miller
L120	.68 uH	Miller
L121	400 uH	E-H Part No. A-10385-01
L122	51 uH	E-H Part No. A-10386-01

TUBES

V1	5651	Sylvania
V2	6AU6	Sylvania
V3	6080	Sylvania
V4	6080	Sylvania
V5	6080	Sylvania
V6	7119	Amperex
V7	7119	Amperex
V8	7119	Amperex
V9	E810F/7788	Amperex
V10	6939	Amperex
V11	6939	Amperex
V12	6939	Amperex
V13	6939	Amperex
V14	7377	Amperex
V15	6939	Amperex
V16	6939	Amperex
V17	7377	Amperex

TRANSISTORS

Q1	2 N 966	Motorola
Q2	2 N 966	Motorola
Q3	2 N 966	Motorola
Q4	2 N 741	Motorola
Q5	2 N 834	Motorola
Q6	2 N 1143	Motorola
Q7	2 N 966	Motorola
Q8	2 N 966	Motorola
Q9	2 N 1143	Motorola
Q10	2 N 834	Motorola
Q11	2 N 1303	Texas Instruments
Q12	2 N 250	Texas Instruments
Q13	2 N 1306	Texas Instruments
Q14	2 N 1305	Texas Instruments
Q15	2 N 250	Texas Instruments

TRANSFORMERS

T 101	E-H Part No. A-10383-01
T 102	E-H Part No. A-10383-01
T 103	E-H Part No. A-10383-01
T 104	E-H Part No. A-10383-01
T 105	E-H Part No. A-10383-01
T 106	E-H Part No. A-10383-01
T 107	E-H Part No. A-10383-01
T 201 (power trans.)	PAECO No. 6-1830

SWITCHES

S51	1-deck, 1-pole, 7-position, non-shorting, E-H Part No. 624-003
S52	1-deck, 2-pole, 3-position, non-shorting, E-H Part No. 624-004
S201	Toggle, DPST, Smith 512
S202	Toggle, DPST, Smith 512

MISCELLANEOUS

F201 Fuse, 115 V operation, 3 amp, slo-blo
230 V operation, 1-1/2 amp, slo-blo

DS201 Pilot light, red, Dialco 249-7841-1431
DS202 Pilot light, red, Dialco 249-7841-1431

Delay capsule, E-H No. A-10387-01

Overload reset, normally open, Grayhill 40-1, clear miniature

Relay, 150 ohms, automatic electric, PP-70060-15A

Timing board assembly, complete including printed circuit board & all components less transistors. 120D-2-3

Printed circuit extender, 18 pin (available as accessory), C-10291-01

Power cord, Belden 17460-S

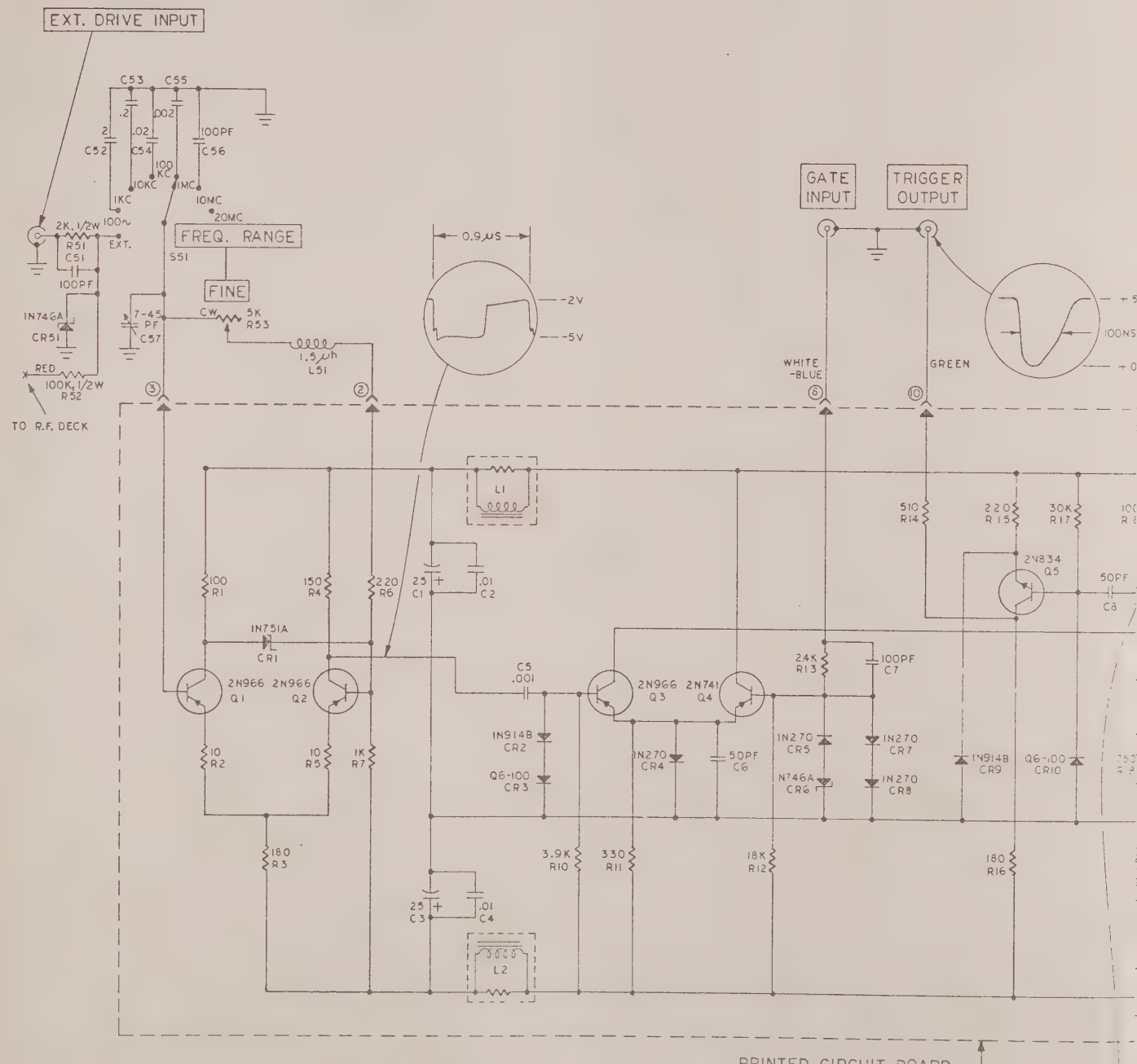
Fuse holder, littlefuse 34201

Fan motor, Barber-Coleman DYAB 569

Fan blade, 4" dia., ccw rotation, Torrington 0429-4

REVISIONS						
ISSUE	REVISION	DATE	DRAWN	CHK'D	APPV'D	E.O.

PROPRIETARY INFORMATION
E-H RESEARCH LABORATORIES, INC.
NO INFORMATION GIVEN HEREIN MAY BE DISSEMINATED TO ANY PERSON OR COMPANY WITHOUT THE EXPRESS PERMISSION OF E-H RESEARCH LABORATORIES, INC.



NOTES:

UNLESS OTHERWISE SPECIFIED,

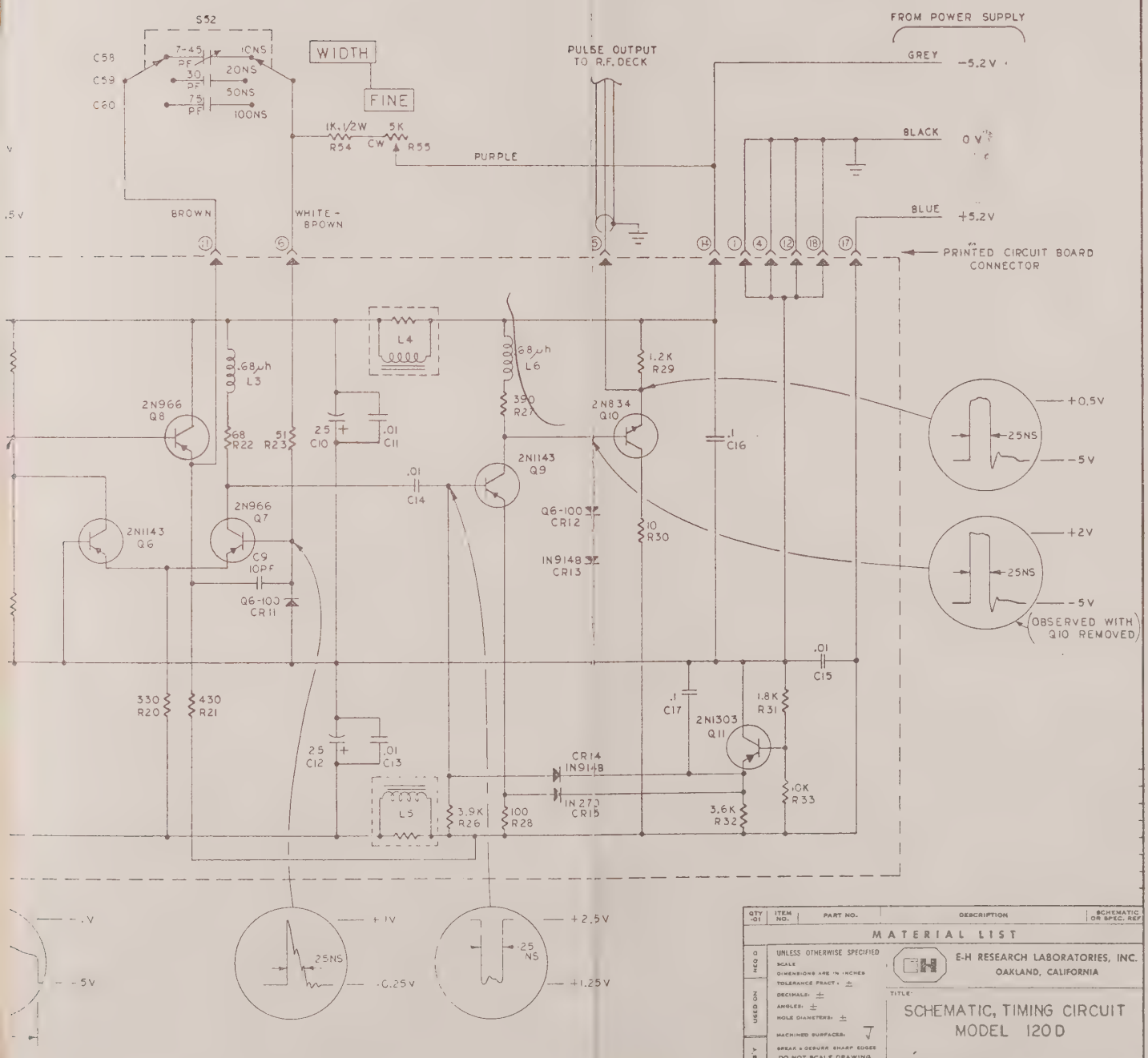
1. ALL RESISTANCES GIVEN IN OHMS.
2. ALL RESISTORS ARE ONE-QUARTER WATT, 5%.
3. ALL CAPACITANCES GIVEN IN MICRO-FARADS (PF = PICO FARADS).
4. WAVEFORMS OBSERVED ON "TEKTRONIX" MODEL 581 OSCILLOSCOPE (TYPE 80 PLUG-IN), WITH MODEL 120D CONTROLS SET AS FOLLOWS:
   - A. FREQ. RANGE SET TO 100KC-1MC. RANGE.
     FINE CONTROL SET TO MAX. (FULL CW).
   - B. WIDTH SET TO 10NS-20NS RANGE.
     FINE CONTROL SET TO MAX. (FULL CW).

D-10403

TITLE: SCHEMATIC, TIMING CIRCUIT MODEL 1200

D-10403

SHEET NO.____OF____



QTY -01	ITEM NO.	PART NO.	DESCRIPTION	SCHEMATIC OR SPEC. REF

MATERIAL LIST

NEXT ASSY | USED ON | NEXT ASSY | VAR.

UNLESS OTHERWISE SPECIFIED
SCALE
DIMENSIONS ARE IN INCHES
TOLERANCE FRACT ±
DECIMALS: ±
ANGLES: ±
HOLE DIAMETERS: ±
MACHINED SURFACES: √
BREAK ALL BURR SHARP EDGES
DO NOT SCALE DRAWING

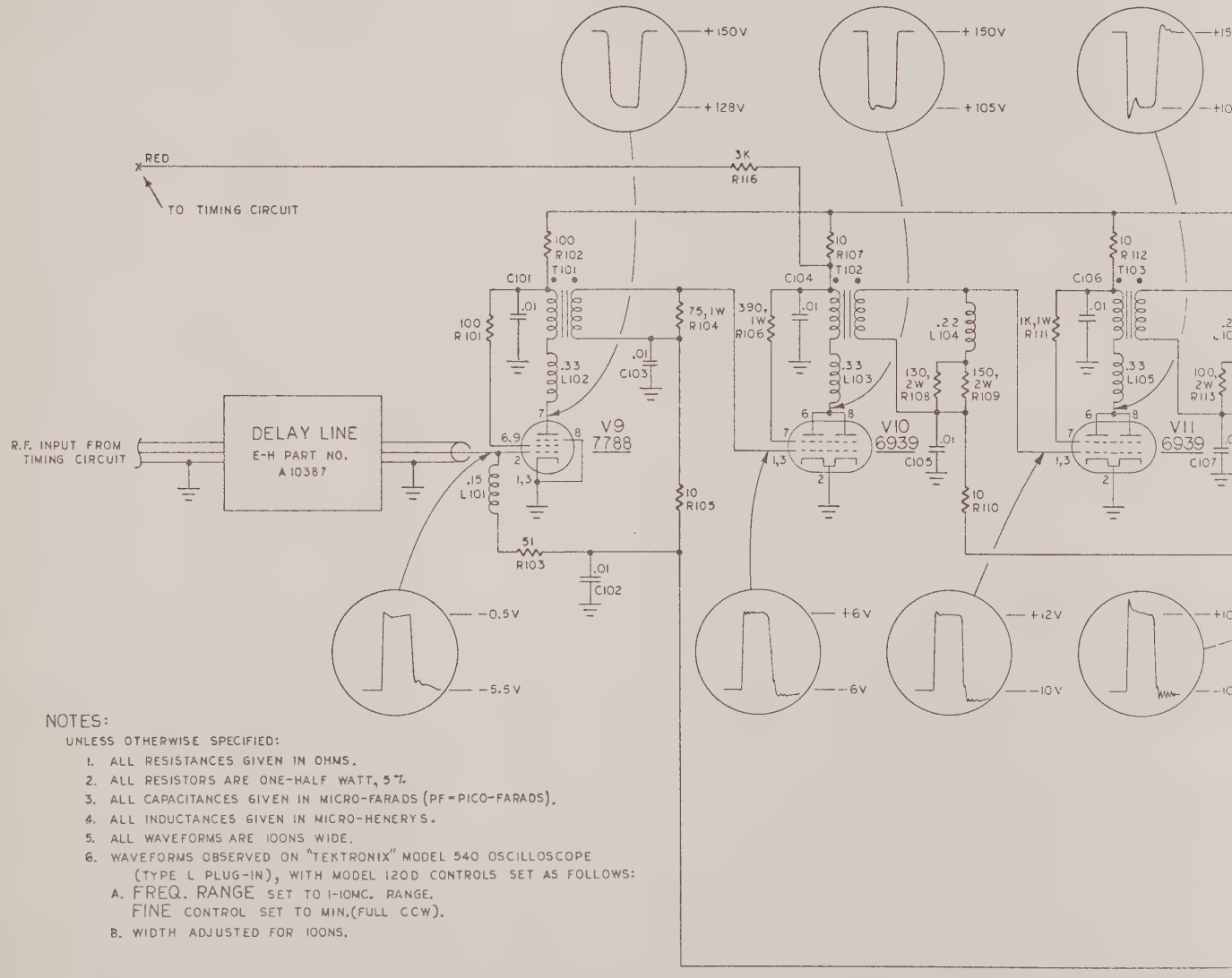
E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE: SCHEMATIC, TIMING CIRCUIT MODEL 120D

	INITIALS	DATE	D. NO.	DWG. NO.	REVS
DRAWN	L.C.	3-1-65		D-10403	
CHK'D					
APP'D				SHEET NO.____OF____SHEETS	

REVISIONS						
ISSUE	REVISION	DATE	DRAWN	CHK'D	APPV'D	E.O

PROPRIETARY INFORMATION
E-H RESEARCH LABORATORIES, INC.
NO INFORMATION GIVEN HEREIN MAY BE DISSEMINATED TO ANY PERSON OR COMPANY WITHOUT THE EXPRESS PERMISSION OF E-H RESEARCH LABORATORIES, INC.



NOTES:

UNLESS OTHERWISE SPECIFIED:

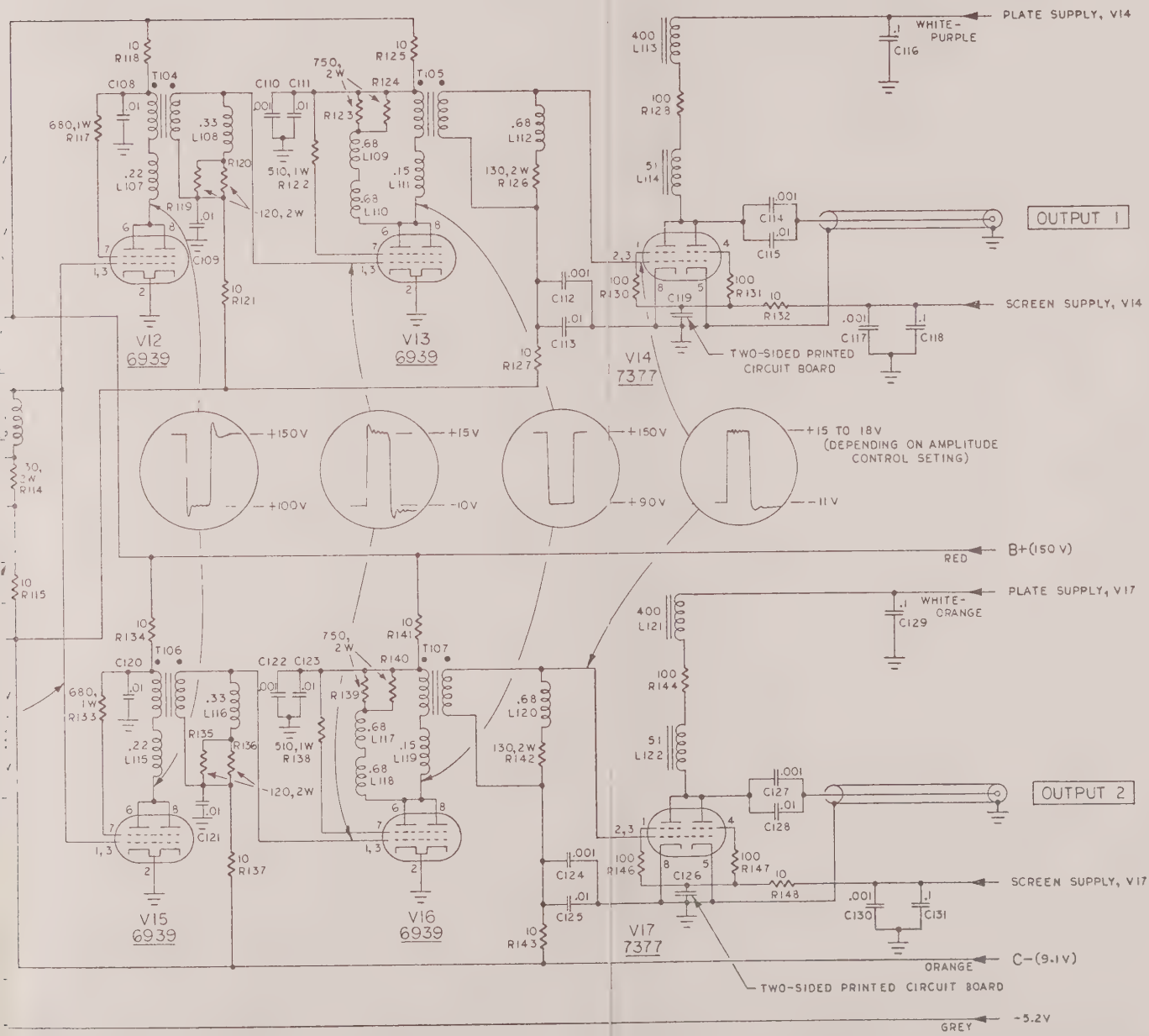
1. ALL RESISTANCES GIVEN IN OHMS.
2. ALL RESISTORS ARE ONE-HALF WATT, 5%.
3. ALL CAPACITANCES GIVEN IN MICRO-FARADS (PF=PICO-FARADS).
4. ALL INDUCTANCES GIVEN IN MICRO-HENERYS.
5. ALL WAVEFORMS ARE 100NS WIDE.
6. WAVEFORMS OBSERVED ON "TEKTRONIX" MODEL 540 OSCILLOSCOPE (TYPE L PLUG-IN), WITH MODEL 120D CONTROLS SET AS FOLLOWS:
   A. FREQ. RANGE SET TO 1-10MC. RANGE.
      FINE CONTROL SET TO MIN.(FULL CCW).
   B. WIDTH ADJUSTED FOR 100NS.

D-10412

TITLE: SCHEMATIC, R.F. DECK MODEL 120D

D-10412

SHEET NO.____OF____



QTY .01	ITEM NO.	PART NO.	DESCRIPTION	SCHEMATIC OR SPEC. REF

MATERIAL LIST

REQ'D | USED ON | NEXT ASS'Y | VAR.

UNLESS OTHERWISE SPECIFIED
SCALE: SOME
DIMENSIONS ARE IN INCHES
TOLERANCE FRACT.: ±
DECIMALS: ±
ANGLES: ±
HOLE DIAMETERS: ±
MACHINED SURFACES: √
BREAK ◇ OSBURR SHARP EDGES
DO NOT SCALE DRAWING
FINISH:

E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

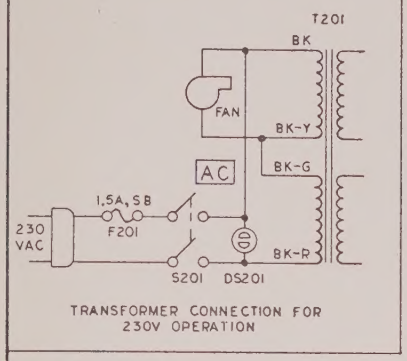
TITLE:
SCHEMATIC, R.F. DECK
MODEL 120 D

	INITIALS	DATE	T.O. NO.	DWG. NO.	ISSUE
DRAWN	LEE	3/15/65		D-10412	
CHK'D					
APP'D					

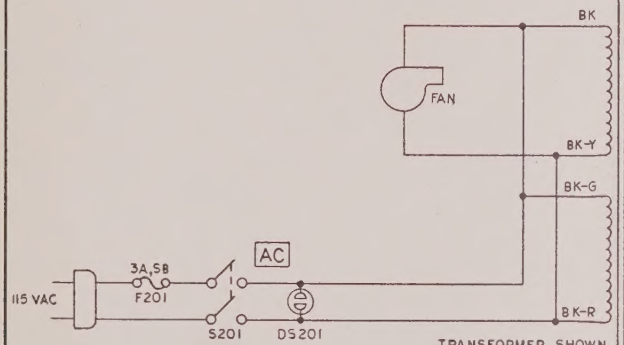
SHEET NO.____OF____SHEETS

REVISIONS						
ISSUE	REVISION	DATE	DRAWN	CHK'D	APP'D	E.O.

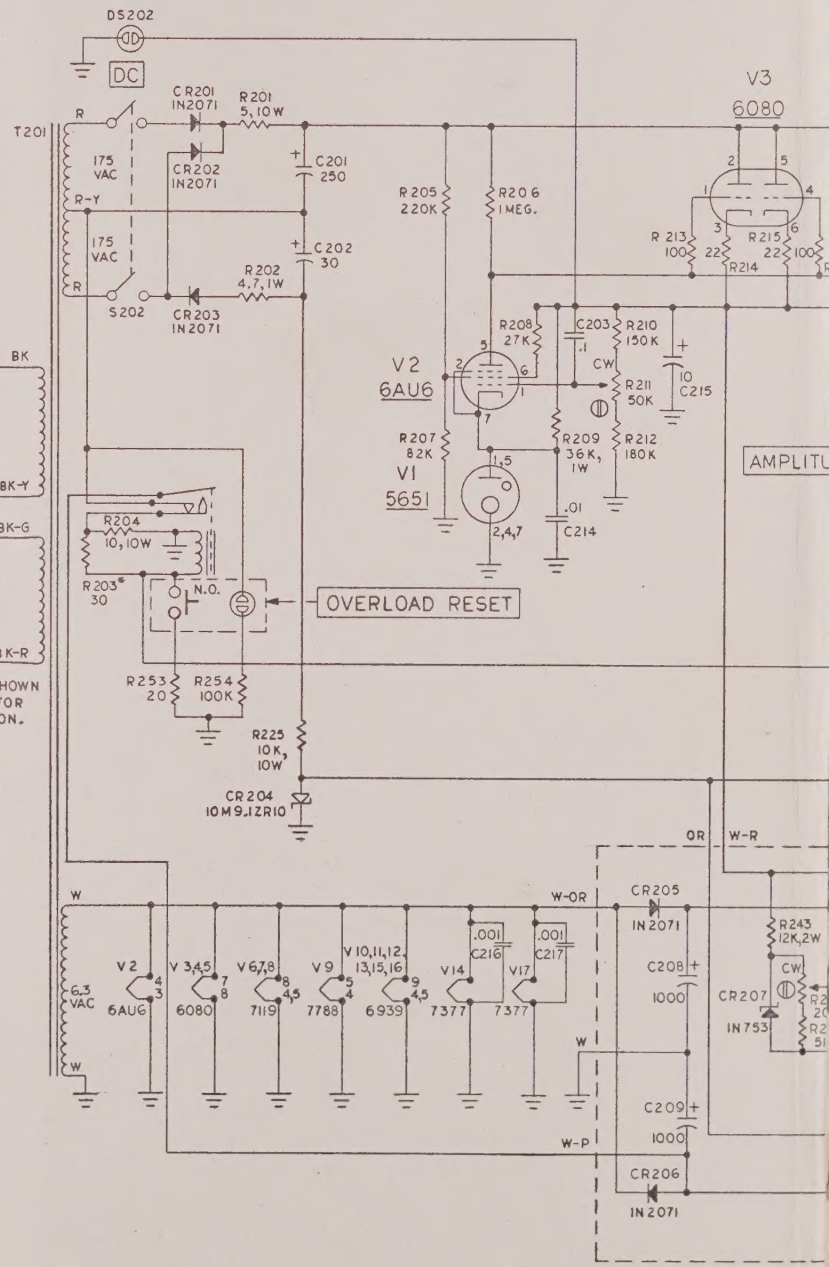
PROPRIETARY INFORMATION
E-H RESEARCH LABORATORIES, INC.
NO INFORMATION GIVEN HEREIN MAY BE DISSEMINATED TO ANY PERSON OR COMPANY WITHOUT THE EXPRESS PERMISSION OF E-H RESEARCH LABORATORIES, INC.



TRANSFORMER CONNECTION FOR 230V OPERATION



TRANSFORMER SHOWN CONNECTED FOR 115V OPERATION.



NOTES:

1. ALL RESISTANCES GIVEN IN OHMS UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTORS ARE ONE-HALF WATT, 5%, UNLESS OTHERWISE SPECIFIED.
3. ALL CAPACITANCES GIVEN IN MICRO-FARADS UNLESS OTHERWISE SPECIFIED.
4. * TYPICAL VALUE SHOWN. COMPONENT MAY BE A DIFFERENT VALUE OR OMITTED.

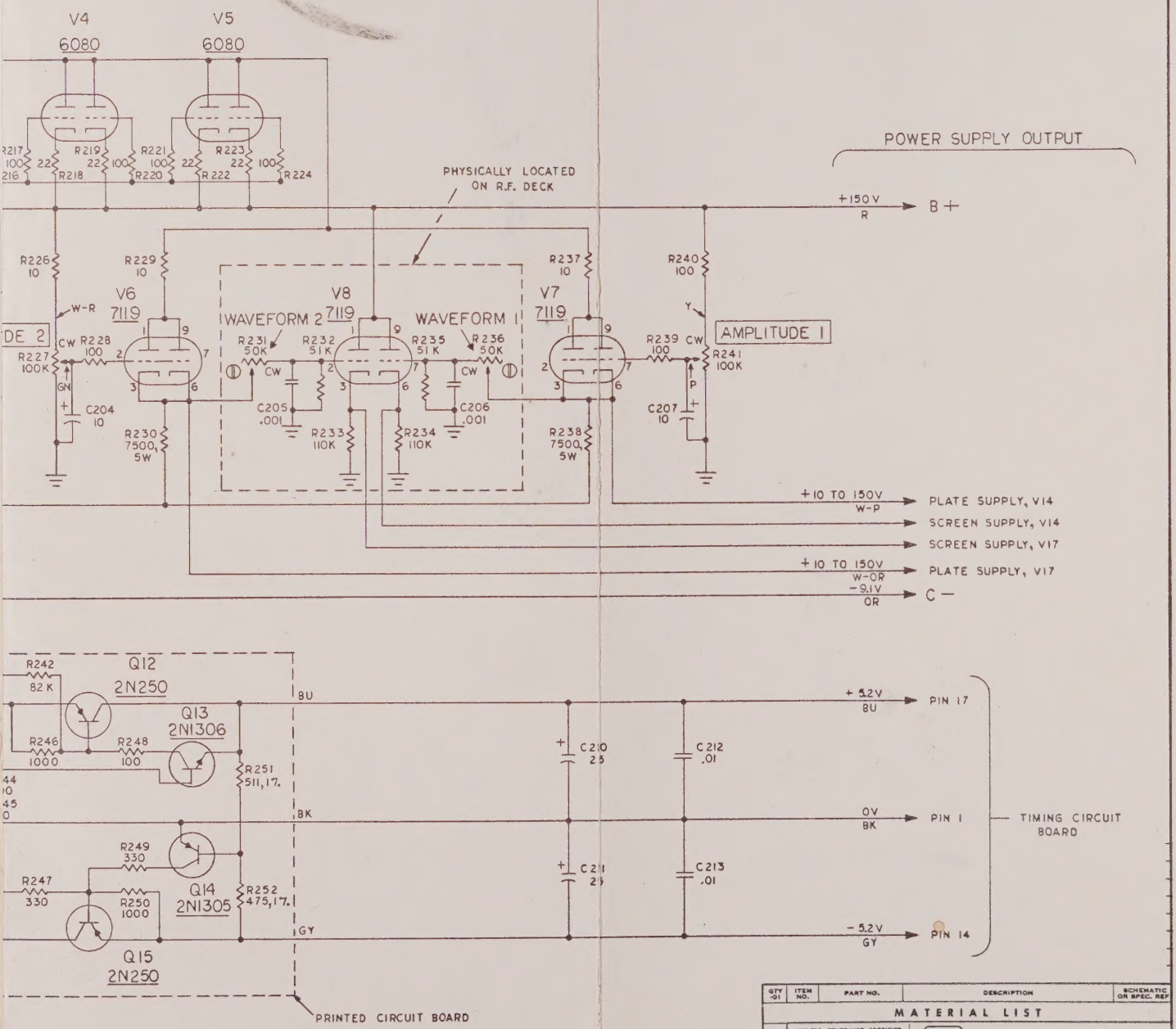
WIRE COLOR CODE	
BLACK	BK
BROWN	BN
RED	R
ORANGE	OR
YELLOW	Y
GREEN	GN
BLUE	BU
PURPLE	P
GREY	GY
WHITE	W

TITLE: SCHEMATIC, POWER SUPPLY MODEL 120D

D-10396

SHEET NO. ____ OF ____

D-10396



QTY -01	ITEM NO.	PART NO.	DESCRIPTION	SCHEMATIC OR SPEC. REF

MATERIAL LIST

UNLESS OTHERWISE SPECIFIED
SCALE:
DIMENSIONS ARE IN INCHES
TOLERANCE FRACT.: ±
DECIMALS: ±
ANGLES: ±
HOLE DIAMETERS: ±
MACHINED SURFACES: √
BREAK & DEBURR SHARP EDGES
DO NOT SCALE DRAWING
FINISH:

REQ'D | USED ON | NEXT ASS'Y | VAR.

E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE: SCHEMATIC, POWER SUPPLY MODEL 120D

	INITIALS	DATE	I.D. NO.	DWG. NO.	ISSUE
DRAWN	L.E.	2/20/62		D-10396	
CHK'D		3/14/62			
APP'D		3/14/62			

SHEET NO. ____ OF ____ SHEETS

www.manualsplus.com
1020371